Developing an Adaptive Robotic Assistant for Close-Proximity Human-Robot Interaction in Space Environments

Completed Technology Project (2014 - 2018)

Project Introduction

As mankind continues making strides in space exploration and associated technologies, the frequency, duration, and complexity of human space exploration missions will continually increase in the years to come. Whether it is a return to the lunar surface, exploring an asteroid, or visiting Mars and its two moons, efficient collaboration between astronauts and robotic systems will be essential to the success and efficiency of future human missions. Improvements in human-robot interfacing and integration can also have substantial near-term benefits, as several new robotic system such as the Dextre, Robonaut 2, and Smart SPHERES have been deployed in the International Space Station in the last five years. The central objective of the proposed research is to enhance human-robot interaction in robotic systems in space in order to unlock the full potential of currently deployed robotic platforms as well as to benefit human space exploration missions in the future. In support of achieving this objective, the specific aims and proposed implementation methods of the research are: 1. Design a safety system capable of ensuring safe and comfortable human-robot interaction by monitoring various parameters such as separation distance, closing rate, and the huma's vision field in order to intelligently adjust the robot's motions. 2. Develop an intent recognition capability based on behavioral models which utilize task-level knowledge and observable parameters such as gaze direction, posture, gestures, and speech to actively predict astronaut intent and respond accordingly. 3. Validate the efficacy of the developed systems, both under nominal conditions as well as with localization uncertainty, through simulation and experimentation by utilizing quantitative measures of human-robot fluency, efficiency, and safety. This research is most closely related to the objectives stated in NASA's Robotics, Tele-Robotics and Autonomous Systems Space Technology Roadmap, in particular the Human-Systems Integration section. Within this section, the Safety, Trust, & Interfacing of Robotic/Human Proximity Operations sub-section describes the need for safe physical interactions, which is highly relevant to the first aim of this research. The Intent Recognition & Reaction sub-section, on the other hand, describes the importance of recognizing astronaut intent and reacting to it in an intelligent way, which is relevant to the second aim.

Anticipated Benefits

Whether it is a return to the lunar surface, exploring an asteroid, or visiting Mars and its two moons, efficient collaboration between astronauts and robotic systems will be essential to the success and efficiency of future human missions. Improvements in human-robot interfacing and integration can also have substantial near-term benefits, as several new robotic system such as the Dextre, Robonaut 2, and Smart SPHERES have been deployed in the International Space Station in the last five years. The central objective of the proposed research is to enhance human-robot interaction in robotic systems in space in order to unlock the full potential of currently deployed robotic

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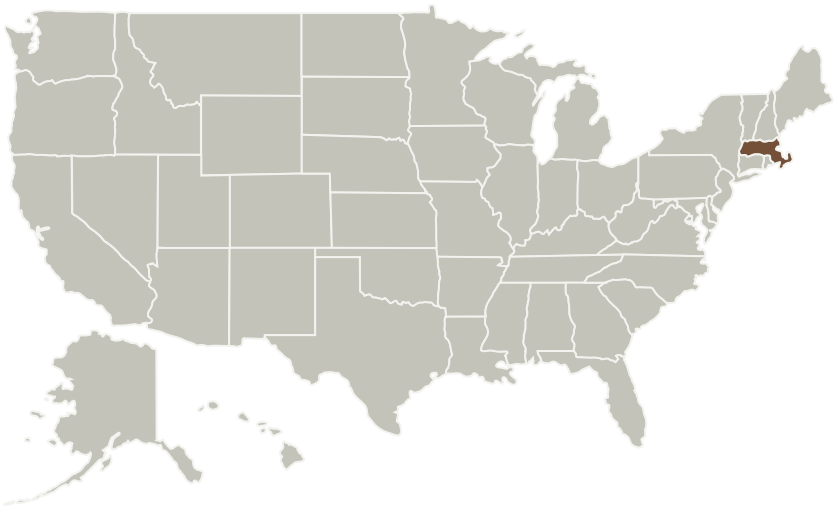
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Massachusetts Institute of Technology(MIT)	Lead Organization	Academia	Cambridge, Massachusetts

Primary U.S. Work Locations
Massachusetts

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Massachusetts Institute of Technology (MIT)

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Julie Shah

Co-Investigator:

Przemyslaw Lasota

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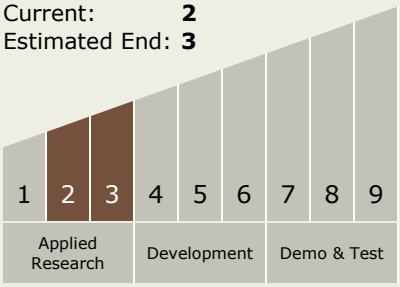
Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX10 Autonomous Systems
  - TX10.3 Collaboration and Interaction
    - TX10.3.4 Operational Trust Building

Target Destinations

Earth, The Moon, Mars